

California High-Speed Train Project



TECHNICAL MEMORANDUM

TYPICAL CROSS SECTIONS FOR 15% DESIGN TM 1.1.21

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System Level Technical and Integration Reviews

The purpose of the review is to ensure:

- Technical consistency and appropriateness
- Check for integration issues and conflicts

System level reviews are required for all technical memorandums. Technical Leads for each subsystem are responsible for completing the reviews in a timely manner and identifying appropriate senior staff to perform the review. Exemption to the System Level technical and integration review by any Subsystem must be approved by the Engineering Manager.

System Level Technical Reviews by Subsystem:

Systems:	<u>Signed document on file</u> Eric Scotson	<u>28 Feb 09</u> Date
Infrastructure:	<u>Signed document on file</u> John Chirco	<u>14 Feb 09</u> Date
Operations:	<u>Signed document on file</u> Paul Mosier	<u>06 Mar 09</u> Date
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Rolling Stock:	<u>Signed document on file</u> Frank Banko	<u>27 Feb 08</u> Date

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APPENDIX A: TYPICAL CROSS SECTIONS FOR 15% DESIGN

APPENDIX B: SUPPLEMENTAL CRITERIA IN SHARED RAIL CORRIDORS

ABSTRACT

Typical cross-sections for 15% design are used to define the guideway to be constructed along the high-speed train alignment, assess the required right-of-way, and prepare capital cost estimates. Schematic cross sections were previously developed as part of the programmatic EIR/EIS in order to advance environmental assessment. This technical memorandum presents HST footprint-level cross sections to be used in advancing the 15% alignment design. Typical cross sections with additional detail will be required to advance the project to the 30% design.

Typical sections for the following high-speed rail conditions will be addressed in this document:

- Two Track At-Grade
- Intermediate Stations
- Rail-Shared Corridors
- Elevated / Aerial Guideway
- Trench / Retained Cut
- Single Track Formations
- Four Track At-Grade

This technical memorandum uses international high-speed train network best practices in developing CHSTP performance criteria. Typical cross sections meet the following high-speed-train requirements:

- Preserving contact between train wheels and rails under all circumstances
- Integration of comfort criteria for passengers while limiting track deformation, air pressure variation, and providing for the mitigating high-speed train noise, where required
- Conditions required for line operation and train regularity
- Inspection and maintenance of the high-speed line
- Ensure drainage of rain water
- Promote efficient execution of earthworks and track installation
- Reduce quantity of ballast or concrete to lay under the track
- Control access to the operating infrastructure
- Allow sufficient space for maintenance of track infrastructure and systems elements in order to limit operational disruptions during inspection and light maintenance activities.

Typical cross-sections will be refined and presented in detail in standard drawings that will be issued at a later stage.

1.0 INTRODUCTION

1.1 PURPOSE OF THE TECHNICAL MEMORANDUM

The purpose of this document is to establish the elements and dimensions that define typical width of the HST cross-sections. These geometric/design elements include:

- Geometric characteristics of the railway track guideway
- Clearance between tracks and adjacent infrastructure
- Overhead contact system poles and systems elements
- Drainage systems
- Control of access
- Maintenance and inspection areas

The intent of these typical cross section is to ensure that sufficient space for the required elements is provided in the width of high-speed train corridor defined at the 15% design level.

This document presents the layout of system elements with standard dimensions in general cases. Particular conditions and specific situations will be addressed in the standard 30% design drawings.

Note that this technical memorandum establishes the requirements for the high-speed rail main tracks. In corridors shared with other train operations, the design must also consider the standards and requirements of the respective railroad owners and operators.

1.2 STATEMENT OF TECHNICAL ISSUE

This document assesses and recommends the respective location and sizing of:

- Tracks
- OCS poles, footings and portal structures
- Signaling and system spaces
- Drainage
- Walkways
- Control of Access

1.2.1 Definition of Terms

The following technical terms and acronyms used in this document have specific connotations with regard to the California High-Speed Train system.

<u>Ballast</u>	Crushed rock layer on which the track is laid. The ballast forms part of the superstructure. For this reason, problems relating to the ballast layer and ballast materials are only referred to here as far as they affect the quality of the earthworks and track bed layers.
<u>Cut and Fill</u>	Construction techniques involving excavation or grading followed by placement and compaction of fill material.
<u>Dedicated Corridor</u>	Railroad route where high-speed trains operate exclusive of other conventional trains.
<u>Design Speed</u>	the maximum permissible speed along a segment of alignment based on the design specification of the track infrastructure, signaling system characteristics, and the maintenance specifications for that class of track.
<u>Design Standard</u>	The design standards presented in this document will normally be described using three terms:
Desirable:	The standard which shall be equaled or exceeded where there are no constraints on the alignment. Desirable horizontal and vertical standards may be used in any combination.

Minimum/Maximum:	The standards which shall be equaled or exceeded where constraints on alignment make Desirable standards unobtainable or significantly more expensive than Minimum/Maximum standards. Where Desirable standards are not obtainable, they shall be approached as nearly as practical.
Exceptional:	The standard which shall be achieved at the absolute minimum and only where Minimum standards are either unobtainable or exorbitantly expensive. Where Minimum standards are not obtainable, they shall be approached as nearly as practical. Approved design variances are required for the use of Exceptional standards.
<u>Embankment or Fill</u>	Artificial mound of imported material, generally made of selected earth, gravel, or stone; built to support the HST when the reference line of the longitudinal profile is above the natural ground.
<u>Gantry</u>	Frame spanning a railroad track or tracks for supporting and displaying signals.
<u>Portal</u>	Frame spanning a railroad track or tracks for supporting overhead contact system equipment.
<u>Geosynthetics</u>	Structural elements made of synthetic materials for use in earthworks and track bed layers construction. A distinction is made between: <ul style="list-style-type: none"> • Geotextiles: geosynthetics (woven or non-woven), which may be used for separation, filtering, drainage and reinforcement. • Geomembranes: Geosynthetics (synthetic or bituminous layer) impermeable to water, which may be used for protection of sensitive subgrade against penetration of surface water or for protecting ground water against pollution. • Geogrids: Fine or coarse mesh geosynthetics, which may be used for separation and reinforcement. • Geocomposite: Compound structure made of at least 2 layers of geosynthetic materials.
<u>Grade, Gradient</u>	The slope of changes in elevation, defined in percentage, as a foot of rise in 100 feet. Sometimes defined in European publications as millimeters of rise in one meter, in which case it is normally written as ‰ .
<u>High-Speed Mainline Tracks</u>	Tracks used exclusively for the operation the high-speed trains.
<u>Maintenance Siding</u>	A track dedicated to parking maintenance trains and connected to a passing track, never to the main line.
<u>Maximum Authorized Speed</u>	The highest speed that is permitted over a specific portion of the railroad. It may be authorized by special instructions of the current timetable, operating rules, or any other publication authorized by the chief operating officer.
<u>OCS Pole:</u>	Vertical structural element supporting the overhead contact system equipment, including auxiliary wires.
<u>Operating Speed</u>	The highest in-service speed that is achievable by a trainset technology on a segment of alignment that conforms to all of the requirements specified for that class of track.
<u>Passing Track</u>	A track connected to the main line on both ends for operating purposes, for example, to deal with delayed train or train with technical incident or to allow an overtaking train.

<u>Prepared Subgrade</u>	<p>The upper part of the subgrade is formed into a prepared subgrade layer, which normally has a cross slope.</p> <p>This layer is made of imported or treated material depending of the quality of the upper part of embankment or the bottom of the cut.</p> <p>Its quality and compactness shall be better than the material below. Its function is to minimize the deformation of the upper part of the embankment or the bottom of the cutting and to prevent water that has passed through the subballast layer from penetrating to the earthworks below.</p>
<u>Rail Shared Corridor</u>	Railroad route where high-speed trains share space within the same right-of-way as another rail operator.
<u>Refuge Track</u>	A dead end track connected to a station track primarily for the purpose of temporary storage of a disabled train.
<u>Shared Track</u>	Segment along the CHSTP alignment, where rail operations are conducted by high-speed trains and another railroad on common track.
<u>Superelevation</u>	The difference in elevation between the outside rail of the curve and the inside rail of the curve measured between the highest point on each rail head. Normally called Cant in European publications.
<u>Station Track / Platform Track</u>	A track for the purpose of bringing a train alongside a station platform so that a stopped train to embark / disembark passengers.
<u>Subgrade</u>	The subgrade is the top of the earthworks, on which the sub-ballast layer rests. On an embankment, the subgrade will be formed of imported soil whereas in a cut, it will be the naturally occurring soil.
<u>Subballast Layer</u>	<p>The subballast is an intermediate layer situated between the ballast and the subgrade layers. It protects the top of the embankment against erosion, ensures a better distribution of loads, and provides a leveled surface suitable for track laying. Subballast is made up of full crushed graduate gravel.</p> <p>This layer is also referred to as the <u>Blanket Layer</u> in the UIC standards.</p>
<u>Ties or Sleepers</u>	Concrete beams laid horizontally on ballast or track bed structure to support and bind rails together at the right gauge.
<u>Track Bed Layers</u>	<p>General term that includes all of the new material imported for the foundation of the track. It includes the ballast and the following elements when present:</p> <ul style="list-style-type: none"> • Sub-ballast layer • Prepared subgrade • Geosynthetics
<u>Track Centerline</u>	The line equidistant between the inside faces of the rail heads of a track.
<u>Track Centers</u>	Distance between adjacent track centerlines.
<u>Track Formation Level</u>	Surface intended to receive the track bed layers.
<u>Unbalance, Unbalanced Superelevation</u>	- The difference between the Superelevation and Equilibrium Superelevation. In European publications, Unbalance is called Cant Deficiency if the actual Superelevation is less than the Equilibrium Superelevation and Excess Cant if the actual Superelevation is greater than the Equilibrium Superelevation.
<u>Upper Part of Embankment</u>	Top three feet of an embankment. Requires high quality design and construction in order to ensure the appropriate bearing-capacity to receive track bed layers.
<u>Wayside Drainage</u>	Drainage system (buried drains, ditches, precast channel drains) laid to collect and discharge surface water, seepage water, and ground water.

Yard Track Track that is used for the storage, sorting or servicing of train cars.

Acronyms

AREMA	American Railway Engineering and Maintenance-of-Way Association
CHSTP	California High Speed Train Project
CFR	Code of Federal Regulations
FRA	Federal Railroad Administration
GO	General Order
CPUC	California Public Utilities Commission
SNCF	Société Nationale des Chemins de fer Français (French National Railway Company)
UIC	Union Internationale des Chemins de fer (International Union of Railways – The French abbreviation is also used in English).
TSI/STI	European Technical Specifications for Interoperability

1.2.2 Units

The California High-Speed Train Project is based on U.S. Customary Units consistent with guidelines prepared by the California Department of Transportation and defined by the National Institute of Standards and Technology (NIST). U.S. Customary Units are officially used in the United States, and are also known in the US as “English” or “Imperial” units. In order to avoid confusion, all formal references to units of measure should be made in terms of U.S. Customary Units.

Guidance for units of measure terminology, values, and conversions can be found in the Caltrans Metric Program Transitional Plan, Appendix B U.S. Customary General Primer (<http://www.dot.ca.gov/hq/oppd/metric/TransitionPlan/Appendix-B-US-Customary-General-Primer.pdf>). Caltrans Metric Program Transitional Plan, Appendix B can also be found as an attachment to the CHSTP Mapping and Survey Technical Memorandum.

2.0 DESIGN STANDARDS AND GUIDELINES

2.1 GENERAL

The general basis for design standards is the applicable “recommended practice” described in the Manual for Railway Engineering of the American Railway Engineering and Maintenance of Way Association (AREMA Manual). The AREMA Manual provides guidance in the engineering of railroads moving freight at speeds of up to 70 mph and passenger trains at speeds of up to 90 mph with the exception of the still to be completed Chapter 17, High Speed Rail Systems.

However, the AREMA Manual guidance varies considerably in scope and detail from existing international high-speed train systems. Therefore, the AREMA Manual is insufficient to develop high-speed train design requirements.

Due to a lack of standards for high-speed operations in the USA, the Authority is preparing a petition for proposed rules of particular applicability based on existing domestic or international standards as may be most appropriate or applicable to the proposed high-speed train system in California. The most common and recognized standard is the European TSI (Technical Specification for Interoperability) which defines a high-speed system based on the following subsystems and topics:

- Infrastructure
- Energy
- Control and Command
- Rolling Stock
- Maintenance
- Operations
- Safety in Tunnels

General system descriptions are informed by technical recommendation from the UIC (International Union of Railways).

2.2 LAWS AND CODES

Design criteria for the CHSTP are under development. When completed, a CHSTP Design Manual will present design standards and guidelines specifically for the design, construction and operation of high-speed railways based on international best practices. Initial high-speed rail design criteria will be issued in technical memoranda that provide guidance and procedures to advance the design of project-specific elements. Criteria for design elements not specific to HST operations will be governed by existing applicable standards, laws, and codes. Since the stations will be located within multiple municipal jurisdictions, state rights-of-way, and/or unincorporated jurisdictions, local building, planning, and zoning codes and laws must be considered.

Applicable codes, rules, standards and guidelines may include but are not limited to:

- TSI: Technical Specifications for Interoperability for the Trans-European Transport Network.

Federal Railroad Administration (FRA) regulations, including:

- CFR Part 213, Track Safety Standards, generally and in particular, Subpart G -Train Operations at Track Classes 6 and Higher.
- CFR Part 214, Railroad Workplace Safety.

California Public Utilities Commission (PUC) General Orders (GO), including:

- GO 26: Clearances on Railroads and Street Railroads as to Side and Overhead Structures, Parallel Tracks and Crossings
- GO 95: Overhead Electric Line Construction. Generally and also see in particular Section VII, Detailed Construction Requirements for Trolley and Electric

Railway Contact and Feeder Conductors and Their Supporting Messengers, Span Wires, Etc (Class T Circuits)

- GO 118: Regulations Governing the Construction, Reconstruction, and Maintenance of Walkways Adjacent to Railroad Trackage and the Control of Vegetation Adjacent Thereto
- GO 164: Rules And Regulations Governing State Safety Oversight Of Rail Fixed Guideway Systems

The CPUC General Orders provide a significant amount of information, yet do not address HST. However, the General Orders are either applicable by law or useful as design guidelines.

Other Design Guidelines:

- The Manual for Railway Engineering of the American Railway Engineering and Maintenance of Way Association (AREMA Manual), in particular the following chapters:
 - Chapter 1: Roadway and Ballast
 - Chapter 5: Track
 - Chapter 17: High Speed Rail Systems
 - Chapter 28: Clearances
 - Chapter 33: Electrical Energy Utilization
- BNSF Railway: Contact information at: www.bnsf.com/tools/fieldengineering.
Headquarters address:
2650 Lou Menk Drive
Fort Worth, TX 76131-2830
- Union Pacific Railroad: Engineering standards at:
www.uprr.com/aboutup/operations/specs/track/index.shtml.
Manager of Industry and Public Projects can provide guidance to further information:
www.uprr.com/reus/roadxing/cross_cal.shtml
Headquarters address:
1400 Douglas Street
Omaha, NE 68179-1001
- Southern California Regional Rail Authority (SCRRA)
Headquarters address:
700 South Flower Street, 26th Floor
Los Angeles, CA 90017-4101
- Caltrain Design Standards: Design standards at:
<http://www.caltrain.com/engineeringstandards/index.html>
Headquarters address:
1250 San Carlos Ave.
San Carlos, CA 94070-1306
- Caltrans Manuals and Standards, including but not necessarily limited to:
 - Highway Design Manual

The most recent version of the above standards shall be applied.

3.0 ASSESSMENT/ANALYSIS

3.1 BACKGROUND

Typical cross-sections for 15% design are used to define the guideway to be constructed along the high-speed train alignment, assess the required right-of-way, and prepare capital cost estimates. Schematic cross sections were previously developed during the programmatic EIR/EIS in order to advance the project's programmatic environmental assessment. This technical memorandum presents typical cross sections to be used for the 15% design based on the design guidelines summarized in Section 6. Typical cross sections with additional detail will be required to advance the project to 30% design.

This technical memorandum considers regulatory requirements and the best practices from existing international high-speed train networks in order to develop CHSTP standards.

3.2 CROSS SECTION ELEMENTS

3.2.1 Terminology

Basic cross section terminology for ballasted and ballastless (slab) tracks are shown in Figures 3.1 and 3.2, respectively.

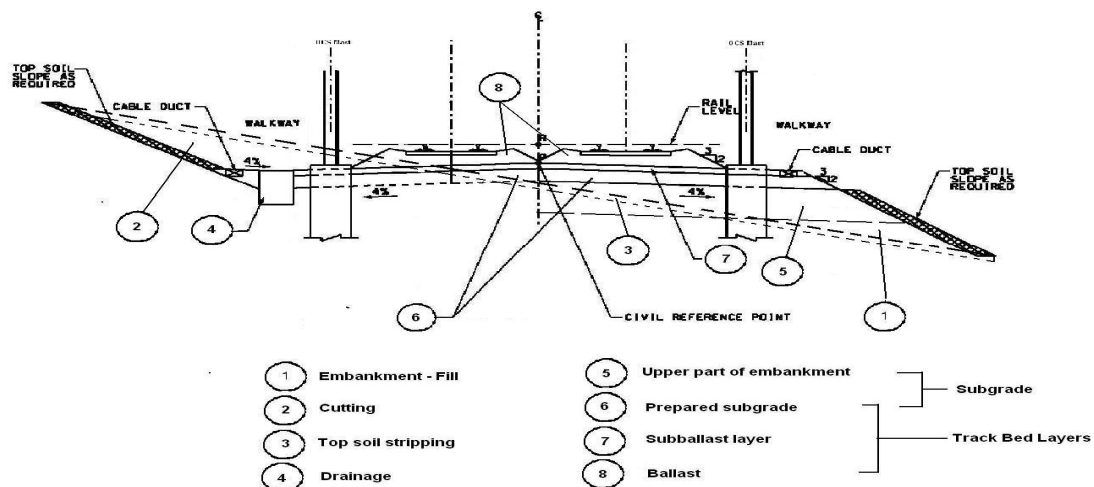


Figure 3.1 - Ballasted Tracks

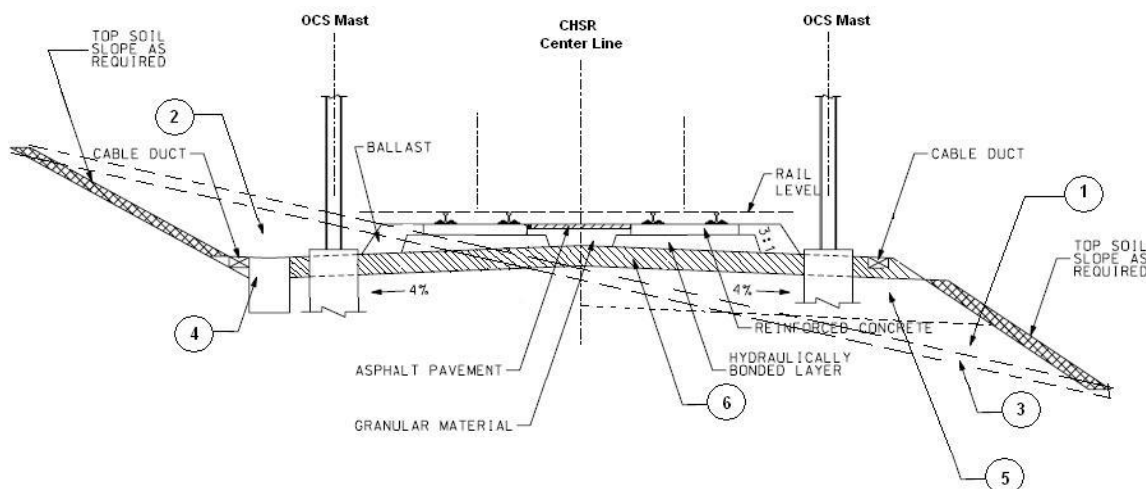


Figure 3.2 - Ballastless Tracks

3.2.2 Minimum Track Centers

The minimum distance between track center lines is based on the two following functional requirements:

- In all circumstances, there should not be any risk of two vehicles on separate tracks colliding. This requirement is addressed by the defined infrastructure clearance for each train on the line.
- Aerodynamic effects when train cross in opposite directions must be compatible with rolling stock design.

Railway companies that run high-speed trains develop their systems according to the rolling stock and the design speed of their respective lines. Table 3.1 presents a summary of the minimum distance between main tracks for existing HST systems.

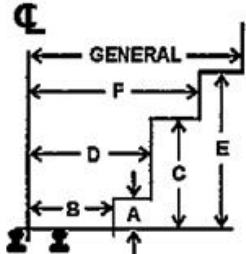
	Line Speed				
	230 kph (143 mph)	270 kph (168 mph)	300 kph (186 mph)	350 kph (217 mph)	400 kph (250 mph)
STI (European Code for Interoperability)	13.20 ft (4.00 m)	13.80 ft (4.20 m)	13.80 ft (4.20 m)	14.80 ft (4.50 m)	
France	13.20 ft (4.00 m)	13.50 ft (4.10 m)	13.80 ft (4.20 m)	14.80 ft (4.50 m)	15.80 ft (4.80 m)
Germany			14.80 ft (4.50 m)	15.40 ft (4.70 m)	
Italy			16.40 ft (5.00 m)	16.40 ft (5.00 m)	
Spain			14.10 ft (4.30 m)	15.40 ft (4.70 m)	
Belgium		13.50 ft (4.10 m)	14.80 ft (4.50 m)		
UK	13.80 ft (4.20 m)	14.80 ft (4.50 m)	14.80 ft (4.50 m)		
Japan		14.10 ft (4.30 m)	14.10 ft (4.30 m)		
China				16.40 ft (5.00 m)	
Taiwan			14.80 ft (4.50 m)	14.80 ft (4.50m)	
South Korea				16.40 ft (5.00 m)	

Table 3.1 – Minimum Mainline Track Centers on Existing High-Speed Train Networks

As the rolling stock for the CHSTP has not yet been selected, it is necessary that the track center be sufficient for the four trainsets were selected by the project as technologies that can most likely meet the CHSTP performance requirements (French AGV, German ICE, Japanese Shinkansen and Spanish AVE). The widest trainset from this list is the Shinkansen, but Japanese operations do not reach the highest CHSTP design speed of 250 mph. Only French high-speeds train systems currently operate at speeds up to the design speed of the CHSTP.

The CHSTP track centers must achieve the minimum legal requirements of the California PUC and the AREMA requirements for California as summarized in Volume 4, Chapter 28 Clearances, Part 3, Table 28-3-3 and presented in Table 3.2.

CALIFORNIA	Regulation Reference		Clearance Between Track Centers								Horizontal clearance		
			Main Tracks	Any Two Subsidiary Tracks	Adjacent Subsidiary Track to Any Main Track	Ladder Track Adjacent to Any Parallel Track	Two Adjacent Parallel ladder Tracks	Lead, repair and Caboose Tracks	Team Tracks in Pairs	Unloading Tracks at Platform	General	Thru Bridges	Highway Bridges
1	2	3	4	5	6	7	8	9	10	11	18	19	20
Imperial units	G.O. 26-D	25/01/1977	14-0	14-0	15-0	20-0	20-0	14-0	13-0	13-0	8-6	8-0	8-6
Metric Units	G.O. 26-D	25/01/1977	4,268	4,268	4,572	6,096	6,096	4,268	3,963	3,963	2,591	2,439	2,591

CALIFORNIA	Regulation Reference		Horizontal Clearance (Continued)								
			Tunnels	Building Doors	Adjacent Subsidiary Track to Any Main Track	Platforms					
											
1	2	3	21	22	23	A	B	C	D	E	F
Imperial units	G.O. 26.-D	25/01/1977	8-0	8-6	8-6	0-8	4-8			4-0	7-6 (NOTE 10)
Metric Units	G.O. 26.-D	25/01/1977	2.439	2.591	2.591	0.204	1.423			1.220	2.286 (NOTE 10)

Note 10: May be 8-0 (2.439m) at 4-6 (1.372m) for refrigerator car platforms only.

CALIFORNIA	Regulation Reference		Horizontal Clearance (Continued)												
			Signals						Poles	Mail Cranes	Icing Docks	Ore and Cole Docks	Cattle Chutes	Wires	Pipelines
			High	Low, between		Switch Boxes,									
				Height	Clearance	Height	Clearance								
1	2	3	30	31	32	33	34	35	36	37	38	39	40	41	
Imperial units	G.O. 26.-D	25/01/1977	8-6	3-0	6-0	0-4	3-0	8-6	6-5 (NOTE 11)	7-8	8-6	8-6	22-06 8-06	22-06 8-06	
Metric Units	G.O. 26.-D	25/01/1977	2.591	0.915	1.829	0.102	0.915	2.591	1.956 (Note 11)	2.337	2.591	2.591	6.858 2.591	6.858 2.591	

Note 11: To ends of arms in operating position.

Table 3.2 – Legal Clearance Requirements for California
Excerpt from AREMA V4 CH28 part 3 table 28-3-3 and 28-3-4

The proposed track centers for the California High-Speed Train project shall meet or exceed the distance shown and the Tables 3.1 and 3.2. Minimum track centers are presented in Table 3.3 for the Desirable, Minimum, and Exceptional values for the distance separating CHSTP main line tracks.

Design Speed		Track Centers, High-Speed Main Tracks					
		Desirable		Minimum		Exceptional	
miles per hour	km/h	feet	mm	feet	mm	feet	mm
>125 – 250	>200 – 400	16.50 ft	5030	16.50 ft	5030	16.50 ft	5030
≤ 125	≤ 200	16.50 ft	5030	15.00 ft	4572	14.00 ft	4496

Table 3.3 –Distance Between Mainline Track Centers

The track center spacing for high-speed main line tracks and passing tracks must provide adequate space for main line drainage and overhead contact system (OCS) poles without requiring the use of expensive portal structures. If it is necessary to use portal structure to support overhead catenaries, then separation between mainline and passing track centers may be reduced.

The French high-speed line design book indicates that a distance of 7.50 m (24.60 ft) is to be used when OCS poles are located between the tracks and that a distance of 6.50 m (21.30 ft) is to be used when there are no OCS poles between tracks.

Proposed track center separation for main line tracks and adjacent tracks for the CHST project are shown in Table 3.4. Variation in the distance between track centers on parallel alignments shall be avoided to the extent practical.

	Desirable	Minimum	Exceptional
With OCS Pole	30.00 ft (9.15 m)	26.00 ft (7.90 m)	22.00 ft (6.71 m)
With Portal structure	25.00 ft (7.62 m)	22.00 ft (6.71 m)	21.30 ft (6.50 m)

Table 3.4 – Distance Between Mainline Track Centers and Passing Track Centers

3.2.3 Overhead Contact System Pole Location

Overhead contact system (OCS) poles shall clear the dynamic envelope of the rolling stock and follow the requirement of the structure gauge. The poles shall be set at a distance that put the pole foundation outside of the ballast in order to ease the construction of the foundation. It is desirable that poles are not located too far away from the center line to avoid excess stress in the pole due to the contact tension.

Distance between the centerline of the OCS pole and the centerline of the closest adjacent high-speed track shall be 10.67 ft (3.25 m).

Placing OCS poles between high-speed mainline tracks is undesirable and should be avoided.

3.2.4 Walkways

High-speed train operations require very high track quality and rigorous maintenance standards. In order to reach the maximum operating speed and maintain safe operations at a range of speeds, it is necessary to have regular infrastructure and track inspection. It is also necessary to minimize periods of stopped or limited operation due to incident.

Due to the train speed, the relative quiet operation of rolling stock, and the distance required for trains to stop, access to CHSTP infrastructure shall be fully restricted to qualified personnel and subject to stringent safety rules. Access into the controlled area, defined as the area of operating infrastructure, is typically protected with fences equipped with intrusion detection devices to alert of unauthorized entry. The limits of operating infrastructure for the CHSTP are illustrated in Figure 3-3.

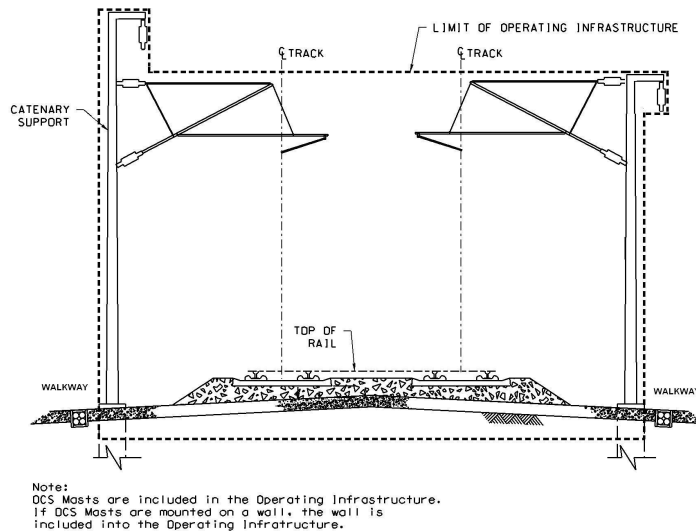


Figure 3.3 – Limits of Operating Infrastructure

a) European Practices

The following are general European practices for access to high-speed train infrastructure during normal revenue service operating hours:

- Entrance in the restricted area shall be signaled to command center and only specifically trained staff are permitted.
- Crossing tracks without specific action restricting operation through the signaling system and with confirmation of the authorization from the command center is prohibited.
- Minimum distance between the track center and the inbound edge of the walkway shall be 11.50 feet minimum in tunnel, cut-and-cover or trench with a handrail and 12.80 feet outside due to aerodynamic consideration. The minimum walkway width range from 2.50 feet on high-speed lines in France to 3.00 feet on CTRL (Channel Tunnel Rail Link) in the United Kingdom and 2.70 feet on the Taiwan high-speed rail system. Due to the presence of OCS poles at 10.67 ft from the track center, the walkway is installed on the outbound side of the OCS poles.
- Entrance into the operating infrastructure envelope, generally delimited by the OCS poles as shown on Figure 3.3, without specific action restricting operation through the signaling system and with confirmation of the authorization from the command center is prohibited.

Based on these points, the following practices are utilized:

- Foot inspection on a walkway outside of the operating infrastructure envelope is possible without a speed restriction on the closest track.
- Foot inspection on an aerial structure is subject to train speed limitations if the walkway is too close of the track (distance depend of operation speed and each country's regulations) and does not have protection against the train's wind effect.

- Inspection in underground structures beyond a certain length (length to be determined based on applicable regulations and the operating rules which are not yet developed) and in tunnels are always subject to operational speed limitations.

a) Japanese (Shinkansen) Practices

Track Inspection is conducted using following track maintenance procedures:

- Right-of-way is protected from unauthorized entry of humans/animals by fences installed along all at-grade sections.
- Train operation time periods and maintenance time periods are separated to eliminate danger for both train traffic and maintenance staff at site.
- In view of safety of working staff and work efficiency, conduct track maintenance work regularly and collectively during the maintenance time period in the night using track maintenance machine fleet.

c) CPUC Requirements

Regulations governing the construction, reconstruction, and maintenance of walkways adjacent to railroad trackage provided in CPUC General Order No. 118, which requires that walkways be a minimum 6.50 feet distance from the track center line and have a minimum width of 2.00 feet.

d) CHSTP Standard

In order to limit impact to operation by inspection, the CHSTP shall:

- Provide inspection walkways on both sides of the high-speed railway with a double track formation and on one side of a single track formation
- Provide maintenance access from public road or access driveway at regular distances on both sides of the right of way
- Place the walkway outside of the operating infrastructure envelope at 12.00 feet from the track center line so inspection can be performed without speed limitation on the closest track. In constrained area where exceptional arrangement is required, The minimum distance from the track center line and the walkway may be reduced to 11.50 feet in tunnels, retained cut, and in trench sections with installation of a handrail.
- In order to increase mobility of staff and tools the inside edge of the walkway on the track side shall be located at the outside limit of the OCS pole foundation. The OCS poles provide a practical delineation of the inside edge of the safe area.

These requirements potentially allow passengers to detrain on the outside edge of the tracks during train evacuation.

CHSTP walkways shall have a width of:

- Desirable: 3.00 ft (36 inches)
- Minimum: 3.00 ft (36 inches)
- Exceptional: 2.50 ft (30 inches)

3.2.5 Longitudinal Drainage Considerations

A high quality level of earthwork placement is required ensure the necessary track quality to operate high-speed trains. There must not be movement of supporting track bed layers and or the underlying earthwork. To avoid risk of movement, it is necessary for all of the layers to be dry and that water ground level is far enough below the track such that there will be no influence on the track bed layers even under the vibration of operating high-speed trains. The depth of the drain, its distance from the track to obtain the right level, plus the necessity to be a safe distance from the track for maintenance, define the drainage area outside of the OCS poles where cable ducts and system equipment will be installed.

Two types of water shall be collected in order to avoid influence on the track bed layer, rain water and ground water. Even when water ground levels are low, rain water must be evacuated from the track bed surface immediately.

The following requirements shall be met in the cross section drainage design:

- The transversal slope on the track bed layer shall never be zero at any point in the cross section.
- In a cut, a drainage device shall be laid at any cross section low points to collect water.
- Particular attention shall be taken to allow water evacuation through any longitudinal elements such as noise barriers, intrusion protection or working staff safety devices.

a) Dimensions

Maintenance of the drainage shall have a minimum disturbance to train operation. Drainage is to be set below trackbed level. This is an important element in dimensioning the drainage, mainly from the perspective of inspection and easy repair.

The drainage type shall be chosen in order of preference:

- Surface facilities such as ditches when there is no ground water to lowered;
- Open channel when space saving is necessary or when ground water level needs to be lowered, and
- A completely buried system.

The minimum drainage system size is calculated based on the water volume it will need to evacuate and monitoring and maintainability requirements. On other high-speed networks these requirements have led to a standard minimum size for drainage systems in order to allow for easy use of tools and monitoring systems. These guidelines include:

- Avoid using ditches with a bottom width of less than 2.0 ft (450 mm) and drain diameters of less than 0.90 ft (250 mm).
- Avoid using very large diameter pipes in case of damage where maintenance works will lead to disturbances due to the size of the trench and the machines which handle the pipes.

It is common to limit maximum pipe size to 48-inches (1200 mm) in order to limit the right of way dimension, to ease the handling in case of maintenance and finally to avoid as much as possible the loading area of the track.

For 15% Design, a 24-inch (600 mm) average pipe size is recommended. According to Caltrans standard drawings, where underdrains are laid in a trench, the width of the trench is the pipe diameter plus one foot. Three (3) feet shall be provided for drainage purposes on each side of a double track formation and on one side of a single track formation.

b) Minimum distance from the OCS Pole Foundation

The drainage is typically installed in advance of the OCS pole foundations; therefore it is necessary to allow a one foot separation between the outside limit of the OCS pole foundation and the edge of the drainage trench. This will avoid damage to the drainage trench during the drilling or excavation of the OCS foundation.

The one foot separation for construction is added to the OCS pole foundation dimension means that the edge of the drainage trench shall not be closer than 3.00 feet from the OCS pole center line.

3.2.6 Systems Elements

Systems elements with cross sectional space requirements include signaling, signs, posts, and cables. It will be also necessary to consider signaling boxes and signaling posts for the 30% design phase.

a) Signaling, Signs, Pole and Pole Footing.

This equipment is located in a 3.0 foot wide space beginning 10.20 feet from the closest track center line, or roughly in the alignment of the OCS pole. At this design stage, it does not impact

the total cross section width. The OSC pole footing is assumed to be 3.0 feet wide (36 inches) for 15% design.

b) Cable Ducts

Due to the quantity of cables used for signaling, telecommunication, and powering of low voltage equipments, cable ducts shall be provided on both sides of the track formation. The cable ducts are located on the external side of the formation on the edge of the subballast layer. The width provided for cable ducts and system equipment shall be a minimum of 3.0 feet in order to allow for a sufficient number of ducts and chambers for cable connections.

3.2.7 Access Control

HST right-of-way shall have controlled access to prevent trespassing by humans and animals. Permanent right-of-way fencing shall include access gates for maintenance personnel and construction contractors, maintenance vehicles and emergency vehicles. Within the vicinity of a station the right-of-way fencing shall be installed to prevent any unsafe short cut to the platform and to guide the passengers to the designated platform entrances. Typical right-of-way fencing is assumed to be 8.0 foot-high minimum and its footing is assumed to be no less than 1.5 feet (18 inches) wide and will incorporate intrusion detection.

Access into the area of operating infrastructure shall be protected with fences equipped with intrusion detection devices to alert of unauthorized entry.

3.3 TRANSITION BETWEEN TRANSVERSE SLOPES

Due to drainage considerations, the transverse slopes on the track bed layer shall never be zero at any point of the cross section. Transition between curves (where there is a single cross fall towards the internal of the curve) and tangent alignments (where there is a double cross fall) shall be regular and smooth in order to insure track stability. Also, it shall be compatible with track laying methodology. In order to simplify cross fall transition design, transition shall take place on the same length as the spiral.

Details of these transitions by track bed layer or the longitudinal gradient of the alignment will be provided for future design levels.

3.4 TYPICAL CROSS SECTIONS

At this preliminary design stage, six conceptual cross sections of typical configurations have been developed to assist in defining the general footprint of the high-speed line, assessing right-of-way requirements, and determine preliminary quantities. These cross sections are developed for at grade and tangent alignments. Note that these cross sections are schematic and are intended to define typical minimum space requirements and not a specific design. The right-of-way required along all segments of the high-speed rail alignment will depend upon actual conditions, including terrain that may require cut/fill slopes, retaining structures, and access requirements.

Typical sections for the following high-speed rail conditions are presented in Appendix A:

- Two Track At-Grade
- Intermediate Stations
- Rail-Shared Corridors
- Elevated / Aerial Guideway
- Trench / Retained Cut
- Single Track Formations
- Four Track At-Grade

4.0 SUMMARY AND RECOMMENDATIONS

Typical cross sections for use in advancing the 15% design are provided in Appendix A.

Supplemental criteria for cross sections in shared-rail corridors are included in Appendix B.

5.0 SOURCE INFORMATION AND REFERENCES

1. Federal Railroad Administration Code of Federal Regulations (CFR)
2. Manual for Railway Engineering of the American Railway Engineering and Maintenance of Way Association (AREMA Manual Chapter 17, High Speed Rail Systems)
3. California Public Utilities Commission General Order 26-D
4. CHST Design Basis Document – California High Speed Rail Program – High Speed Rail System Design Comparison.
5. California High-Speed Train Project Basis of Design (20 December 2007)
6. CHST Design Criteria Draft. *Alignment and Platform Criteria for Conceptual Design-2007*
7. Americans with Disabilities Act (ADA) Accessibility Guidelines
8. CHSTP Technical Memorandum 0.3 – Basis of Design. *General Update, Revision 1*, 2007
9. CHSTP Technical Memorandum 1.1.10 - Structure Gauges (release pending)
10. CHSTP Technical Memorandum 2.1.2 – Alignment Design (release pending)
11. Technical Specification for Interoperability, 'Infrastructure' Subsystem, EU Directive 96/48/EC as modified by the Commission Decision of 20 December 2007 (2008/217/EC)
12. California PUC and the AREMA requirements for California as summarized in Volume 4, Chapter 28 Clearances, Part 3, Table 28-3-3
13. Caltrain Design Criteria (April 15, 2007)
14. SNCF high-speed design book (Technical Requirements for East TGV – Book 1 – Tome 1)

6.0 DESIGN MANUAL CRITERIA

6.1 15% DESIGN CROSS SECTIONS

Typical high-speed rail configurations have been developed to assist in defining the general footprint of the high-speed line, assessing right-of-way requirements, and determine preliminary quantities. These cross sections are developed for at grade and tangent alignments. Note that these cross sections are schematic and are intended to define typical minimum space requirements and not a specific design. The right-of-way required along all segments of the high-speed rail alignment will depend upon actual conditions, including terrain that may require cut/fill slopes, retaining structures, and access requirements.

Typical sections for the following basic high-speed rail conditions are presented in Appendix A:

- Two Track At-Grade
- Intermediate Stations
- Rail-Shared Corridors
- Elevated / Aerial Guideway
- Trench / Retained Cut
- Single Track Formations
- Four Track At-Grade

6.1.1 Clearances

See Structure Gauges Technical Memorandum.

6.1.2 Track Centers

The distance between the center lines of main line tracks is given in the Table 6.1 and is based on design speed. Variation in the distance between track centers on parallel alignments shall be avoided to the extent practical.

Design Speed		Minimum Track Centers, High-Speed Main Tracks					
		Desirable		Minimum		Exceptional	
miles per hour	km/h	feet - inches	mm	feet - inches	mm	feet - inches	mm
>125 – 250	>200 – 400	16.50 ft	5030	16.50 ft	5030	16.50 ft	5030
≤ 125	≤ 200	16.50 ft	5030	15.00 ft	4572	14.00 ft	4496

**Table 6.1 – Distance between Mainline Track Centers
For CHSTP**

The track center between a mainline track and the closest passing track is given in Table 6.2.

	Desirable	Minimum	Exceptional
With OCS Pole	30.00 ft (9.15 m)	26.00 ft (7.90 m)	22.00 ft (6.71 m)
With Portal Structure	25.00 ft (7.62 m)	22.00 ft (6.71 m)	21.30 ft (6.50 m)

**Table 6.2 – Minimum Track Centers between Mainline
and Passing Tracks for CHSTP**

6.1.3 Overhead Contact System (OCS) Poles

The overhead contact system (OCS) poles shall clear the dynamic envelope of the rolling stock without being too far from the center line in order to avoid stress to the OCS pole due to the contact tension.

The distance between the center line of the OCS pole and the center line of the adjacent track shall be 10.67 ft (3.25 m). Placing OCS poles between high-speed mainline tracks is undesirable and should be avoided.

A nominal width of the OCS pole footing shall be 3.00 ft (36 inches) wide for 15% design.

6.1.4 Walkways

A walkway shall be provided on both sides of a high-speed railway with a double track formation and on one side of a single track formation with the inside edge of the walkway at the outside limit of the OCS pole foundation.

CHST walkways shall have a width of:

- Desirable: 3.00 ft
- Minimum: 3.00 ft
- Exceptional: 2.50 ft

6.1.5 Drainage Requirement

A 3-foot-wide area, the edge of which is located 3 feet (min.) from the OCS pole center line shall be reserved on both sides of a double track formation or on one side of a single track formation for drainage purposes.

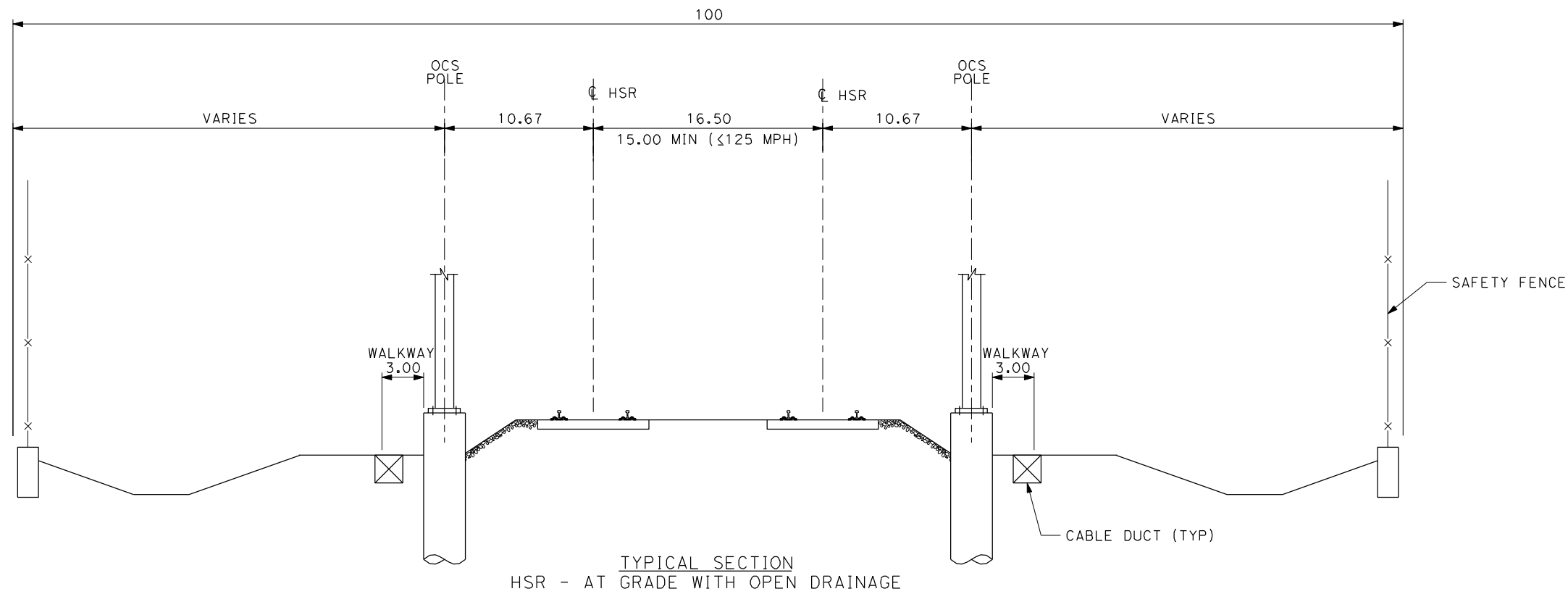
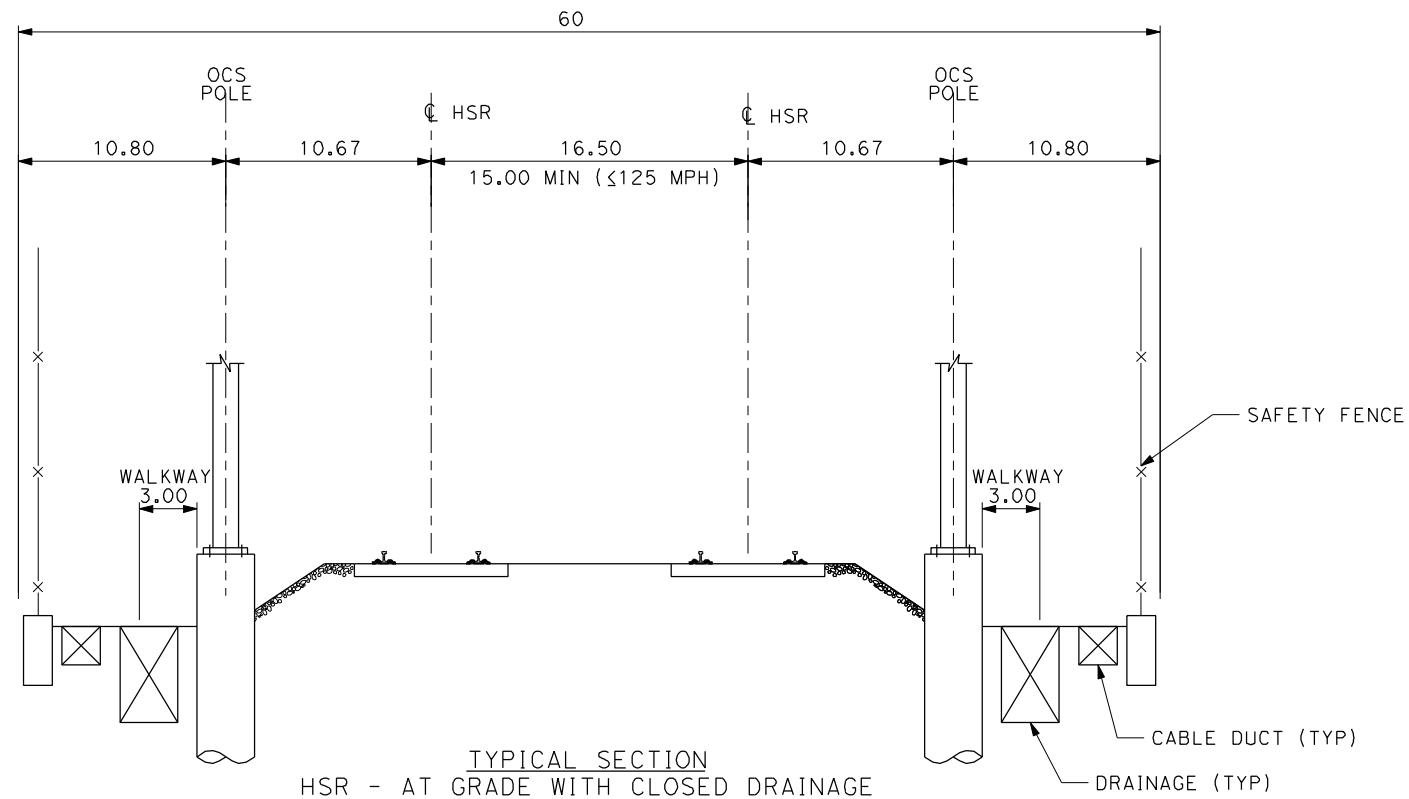
6.1.6 Systems Elements Requirement

A 3-foot-wide area located on both sides of a double track formation or on one side of a single track formation at the edge of the sub ballast layer shall be preserved for cable ducts and system equipment.

6.1.7 Access Control


High-speed train right-of-way shall have fully controlled access to prevent trespassing by humans and animals. Permanent right-of-way fencing shall include access gates for maintenance personnel and construction contractors, maintenance vehicles and emergency vehicles. Typical right-of-way fencing is assumed to be 8.00 ft high minimum and its footing is assumed to be no less than 1.50 ft (18 inches) wide.

APPENDIX A - Typical Cross Sections for 15% Design

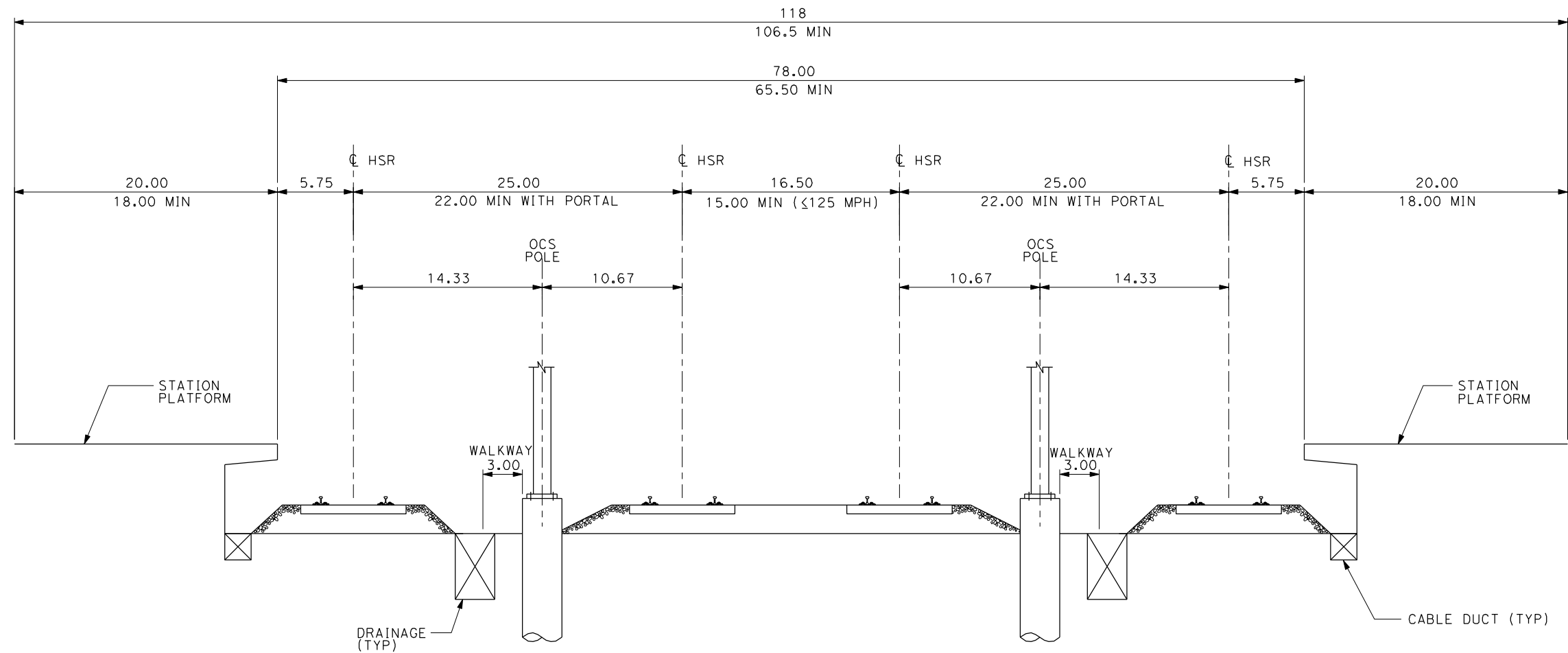


- NOTES:**
1. TRACK, OCS POLES AND FOUNDATIONS, CABLE DUCTS, AND DRAINAGE ARE SCHEMATIC AND DO NOT REPRESENT DESIGN.
 2. RIGHT-OF-WAY REQUIRED FOR THE HIGH-SPEED RAIL GUIDEWAY WILL DEPEND UPON CONDITIONS ALONG THE ALIGNMENT, INCLUDING TERRAIN, WHERE CUT/FILL SLOPES, RETAINING STRUCTURES, AND ACCESS ARE REQUIRED.



						DESIGNED BY D. RULENS		CALIFORNIA HIGH-SPEED TRAIN PROJECT	CONTRACT NO. 13259
						DRAWN BY P. DO			DRAWING NO. C0301
						CHECKED BY J. CHIRCO			SCALE AS SHOWN
						IN CHARGE K. JONG			SHEET NO. ### OF ###
						DATE 4-01-09			
INTERNAL DRAFT						REGIONAL ENGINEERING CONSULTANT / LOGO		HSR TWO TRACK AT-GRADE	
REV	DATE	BY	SUB	APP	DESCRIPTION				

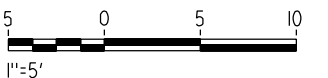
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TYPICAL SECTION
4-TRACK INTERMEDIATE STATION
OUTSIDE BOARDING PLATFORMS

NOTES:

1. TRACK, OCS POLES AND FOUNDATIONS, CABLE DUCTS AND DRAINAGE ARE SCHEMATIC AND DO NOT REPRESENT DESIGN.
2. OCS POLES AT PASSENGER STATIONS ON A SINGLE MAST THAT CANTILEVERS MAY SERVE MAINLINE TRACK AND PLATFORM TRACK.
3. RIGHT-OF-WAY REQUIRED FOR THE HIGH-SPEED RAIL GUIDEWAY WILL DEPEND UPON CONDITIONS ALONG THE ALIGNMENT, INCLUDING TERRAIN, WHERE CUT/FILL SLOPES, RETAINING STRUCTURES, AND ACCESS ARE REQUIRED.



REV	DATE	BY	SUB	APP	DESCRIPTION

INTERNAL DRAFT

DESIGNED BY D. RULENS
DRAWN BY P. DO
CHECKED BY J. CHIRCO
IN CHARGE K. JONG
DATE 4-01-09

REGIONAL ENGINEERING
CONSULTANT / LOGO



CALIFORNIA HIGH-SPEED RAIL AUTHORITY
FLY CALIFORNIA
Without ever leaving the ground.

CALIFORNIA HIGH-SPEED TRAIN PROJECT

INTERMEDIATE HSR STATION

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DRAWING NO. C0302
SCALE AS SHOWN
SHEET NO. ### OF ###



HSR IN RAIL - SHARED CORRIDOR

-

						DESIGNED BY D. RULENS	 <div>CALIFORNIA HIGH-SPEED RAIL AUTHORITY</div> <div>FLY CALIFORNIA</div> <div>Without ever leaving the ground.</div>	CALIFORNIA HIGH-SPEED TRAIN PROJECT	CONTRACT NO. 13259
					DRAWN BY A. CHEUNG	DRAWING NO. C0303			
					CHECKED BY J. CHIRCO	SCALE AS SHOWN			
					IN CHARGE K. JONG	SHEET NO. ### OF ###			
INTERNAL DRAFT						DATE 4-01-09			
REV	DATE	BY	SUB	APP	DESCRIPTION				



- NOTES:



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1. TRACK, CABLE DUCTS AND DRAINAGE ARE SCHEMATIC AND DO NOT REPRESENT DESIGN.
2. SYSTEM AND/OR SAFETY NICHE REQUIRED FOR LONG TRENCH GREATER THAN 3000 FT.
3. RIGHT-OF-WAY REQUIRED FOR THE HIGH-SPEED RAIL GUIDEWAY WILL DEPEND UPON CONDITIONS ALONG THE ALIGNMENT, INCLUDING TERRAIN, WHERE CUT/FILL SLOPES, RETAINING STRUCTURES, AND ACCESS ARE REQUIRED.



TWO TRACK HSR IN TRENCH / RETAINED CUT

CONTRACT NO.
13259

DRAWING NO.
C0305

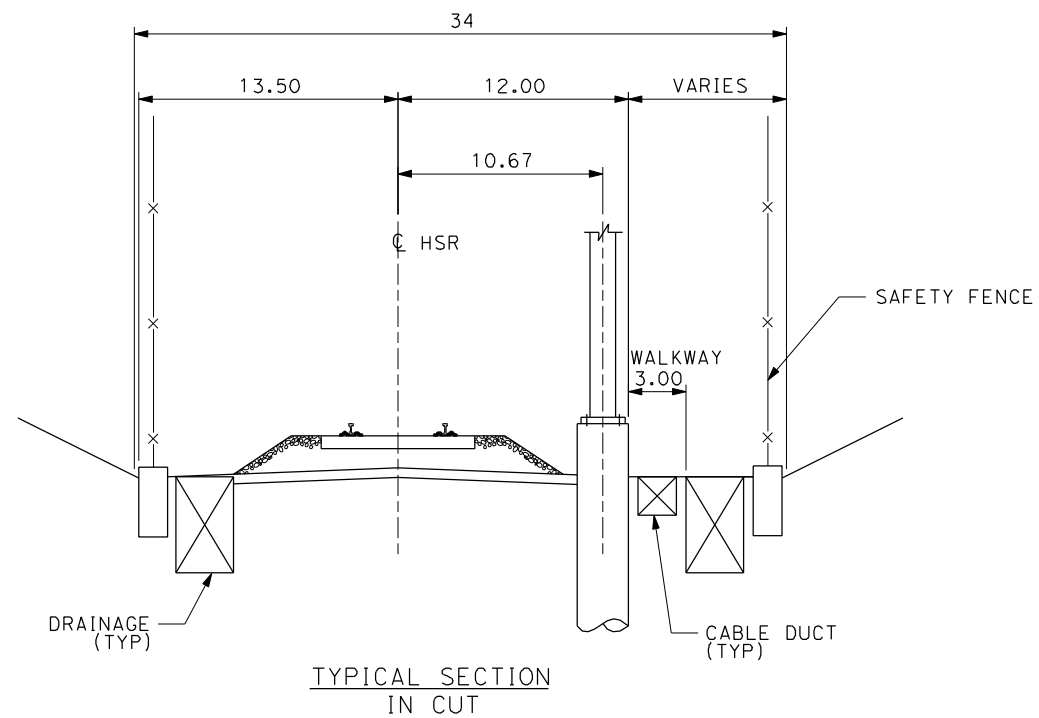
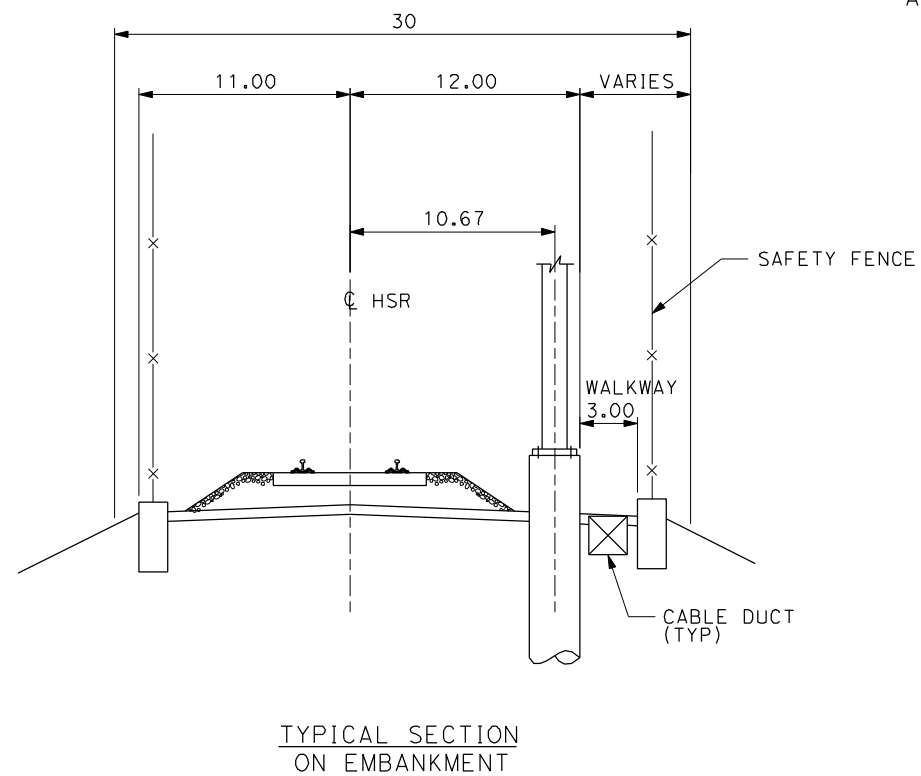
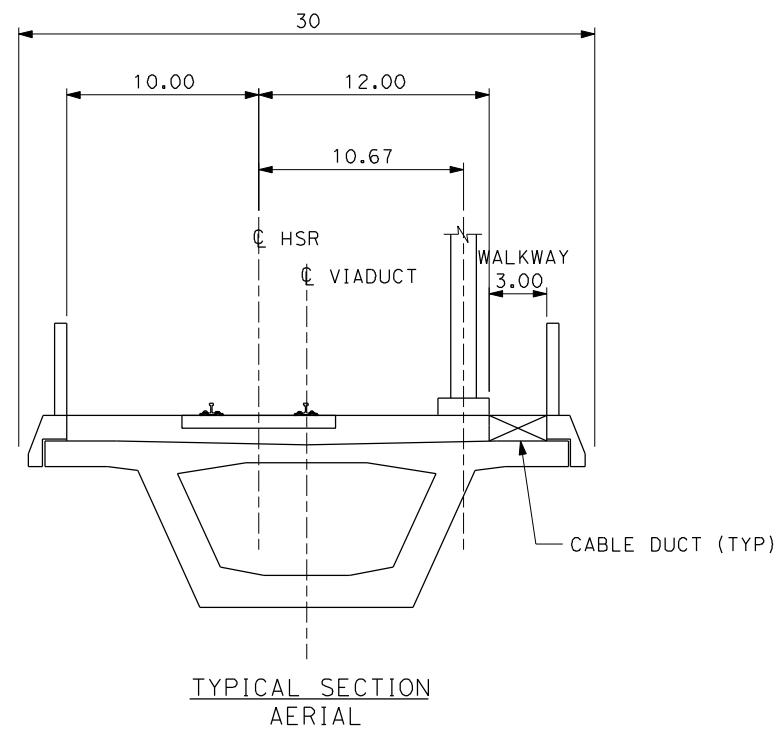
SCALE
AS SHOWN

SHEET NO.
OF

					INTERNAL DRAFT
REV	DATE	BY	SUB	APP	DESCRIPTION

DESIGNED BY D. RULENS
DRAWN BY H. NGUYEN
CHECKED BY J. CHIRCO
IN CHARGE K. JONG
DATE 4-01-09

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- NOTES:
1. TRACK, OCS POLES AND FOUNDATIONS, CABLE DUCTS AND DRAINAGE ARE SCHEMATIC AND DO NOT REPRESENT DESIGN.
 2. RIGHT-OF-WAY REQUIRED FOR THE HIGH-SPEED RAIL GUIDEWAY WILL DEPEND UPON CONDITIONS ALONG THE ALIGNMENT, INCLUDING TERRAIN, WHERE CUT/FILL SLOPES, RETAINING STRUCTURES, AND ACCESS ARE REQUIRED.



REV	DATE	BY	SUB	APP	DESCRIPTION

DESIGNED BY
D. RULENS
DRAWN BY
A. CHEUNG
CHECKED BY
J. CHIRCO
IN CHARGE
K. JONG
DATE
04-01-09



REGIONAL ENGINEERING
CONSULTANT / LOGO

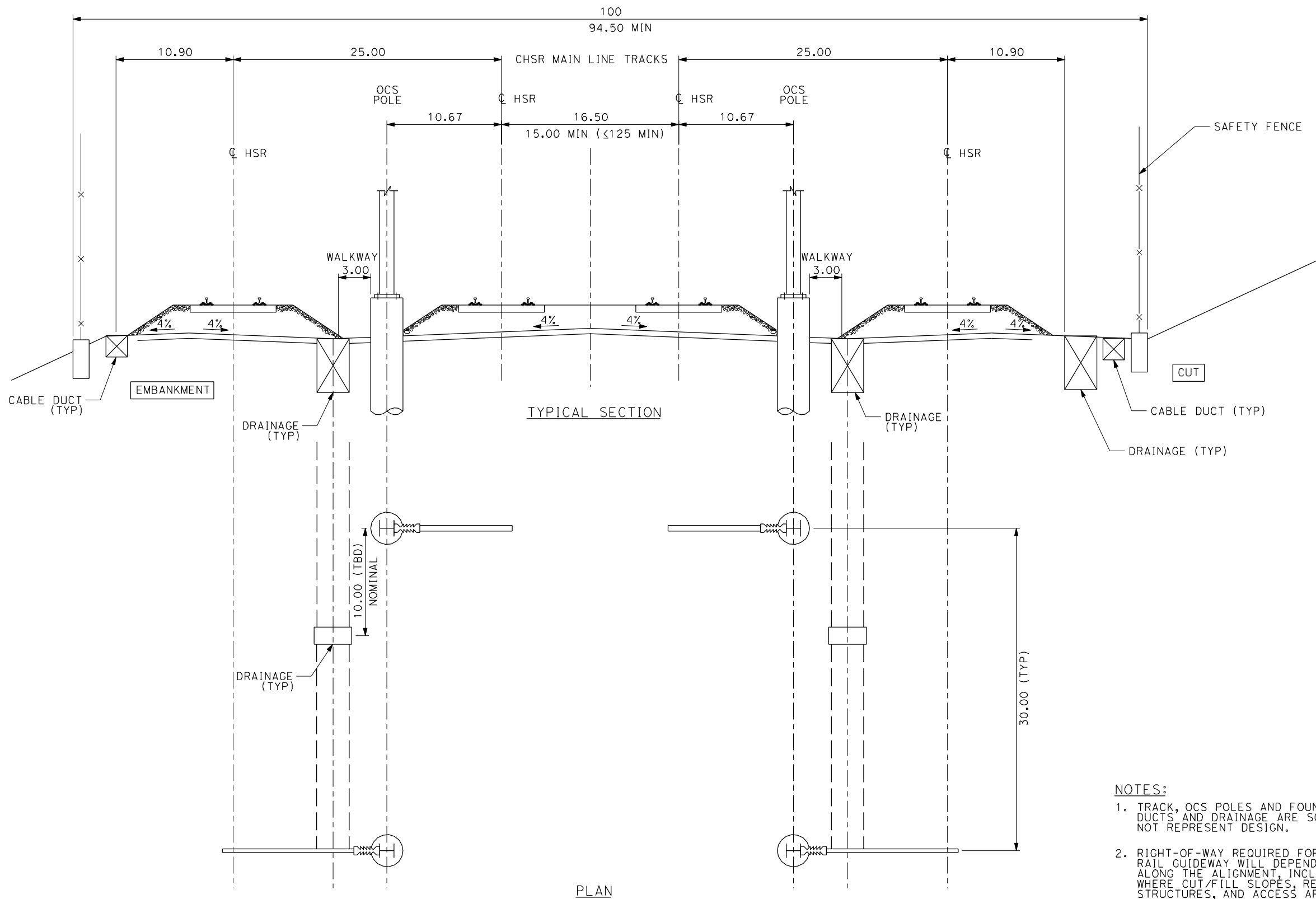


CALIFORNIA HIGH-SPEED TRAIN PROJECT

HSR - SINGLE TRACK FORMATION

CONTRACT NO.
13259
DRAWING NO.
C0306
SCALE
AS SHOWN
SHEET NO.
OF

4/3/2009 1:44:19 PM T:\13259B Calif High Speed Rail\CADD\Updated Figures\Cross Sections\PRO-C-0307.dgn
cheung



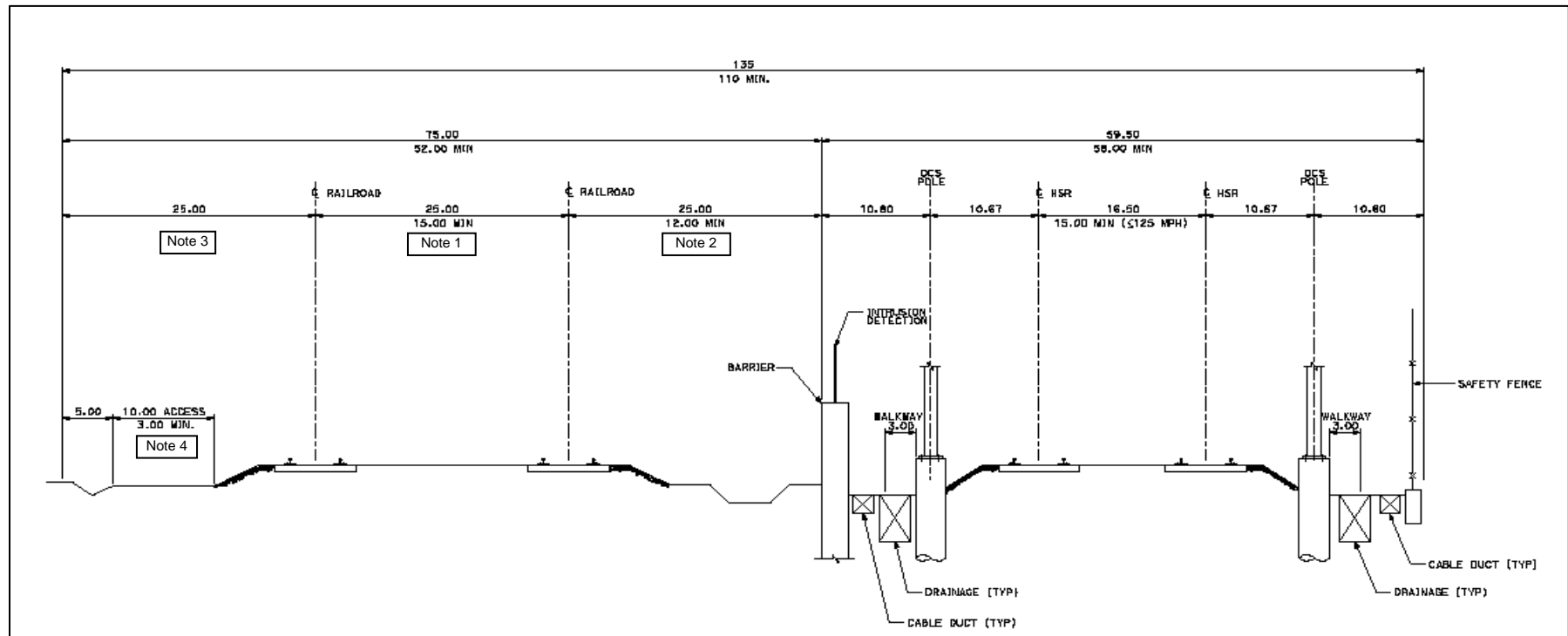
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APPENDIX B – Supplemental Criteria in Shared Rail Corridor

APPENDIX B
SUPPLEMENTAL DATA FOR SHARED RAIL CORRIDOR



Note Number	Cross Section Element	Desired / Minimum Distance			
		CPUC	AREMA	Freight RR	Caltrain
1	Track Centers - Mainline Tracks	14' - 0"	14' - 0"	25'-0" (BNSF) 20'-0" (UP)	15'-0" Min.
2	Permanent Structures	8' - 6"	25'-0" / 9'-0"	25' - 0"	25'-0"
3	Distance to ROW	No Indication	No Indication	25' - 0"	No Indication
4	Access Road / Walkway	2'-0"	No Indication	10' (BNSF)	2'-0" Min.
	Minimum Vertical Clearance	22'-6"	23'-0"	23'-4"	24'-6"
	Temp. Horizontal Clearance			15' (BN) / 12' (UP)	
	Temp. Vertical Clearance			21'	